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COLLAPSIBLE TUBULAR STRUCTURE

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The present invention relates to a rigid tubular structure and more particularly to a collapsible structure which may be stored in a compact roll and then extended into a rigid tube having a preformed diameter.

With increased emphasis on subminiaturization and compactness, the need has arisen to develop an elongated tubular structure which may be collapsed and stored in a relatively small area when not in use and then readily extended and formed into an elongated rigid tube when the need arises.

An obvious approach to the problem of storing extensible structures in a compact manner is the one utilized by preformed steel measuring tapes. This technique is well known and extensively described in the prior art. The strength of such structures is limited to one plane and while a certain amount of rigidity is imposed by the curved preforming this strength is limited and such tapes can quite easily be deformed by folding. Prior efforts to increase the rigidity of this structure such as described in U.S. Patent No. 2,157,278 were limited to complete cylindrical deformation of the ribbon prior to rolling and were unable to withstand torsional stresses. The present invention describes a method of providing torsional rigidity to such collapsible structures.

Therefore, an object of the present invention is to provide an improved collapsible tubular structure.

Another object of the present invention is to provide an improved collapsible tubular structure which may be rolled for storage without affecting the rigidity of the subsequently extended tube.

A further object of the present invention is to provide a collapsible tubular structure having increased torsional strength.

Briefly, the improved tubular structure of the present invention includes a flat thin ribbon of prestressed metallic or plastic material having a specific ratio of width to thickness which is preformed and set in a tubular shape and is rolled into a compact configuration for storage and then subsequently unrolled for use. To provide torsional strength to the tube, a means of uniting the abutting edges is provided, such as, for example, serrations along the longitudinal edges of the ribbon which are automatically interdigitated as the ribbon is unrolled or the application to the outer surface of the tube adjacent to the seam formed by the abutting edges of the ribbon of a tape having an adhesive surface in contact with the tube.

Other advantages of the invetnion will hereinafter become more fully apparent from the following description of the drawings which illustrate a preferred embodiment thereof and in which:

FIG. 1 is an enlarged perspective view of one embodiment of the improved collapsible tubular structure of the present invention illustrating the ribbon in a rolled configuration and showing a portion of it unrolling into its pre-stressed tubular configuration;

FIG. 2 is an enlarged perspective view of the improved collapsible tubular structure of the present invention showing the ribbon unrolled into its tubular shape and a strip of adhesive being applied to the tube adjacent to the seam to illustrate a first method of providing torsional rigidity to the tube;

FIG. 3 is an enlarged perspective view of a portion of the improved collapsible tube of the present invention

showing the interdigitation of serrations formed along the longitudinal edge to illustrate a second method of providing torsional rigidity to the tube;

FIG. 4 is an enlarged perspective view of a second embodiment of the improved collapsible tube of the present invention and having a portion cut away to illustrate a third method of providing torsional rigidity; and

FIG. 5 is an enlarged perspective view similar to FIG. 4 and having a portion cut away to illustrate the use of serrations and notches in place of the adhesive layer of FIG. 4 to provide torsional rigidity.

Referring to FIG. 1, the improved collapsible tube of the present invention comprises an elongated sheet or ribbon **10** of flat, relatively thin pre-stressed material such as spring steel, beryllium copper, spring type stainless steel or plastic which has been preformed into an elongated tube **16** having a precise diameter. So that the tube may be rolled into a roll **14** suitable for storage and then unrolled into its preformed tubular shape **16**, the ribbon is a size which provides a ratio of width to thickness typically in the order of from 200–2000.

In the case of metallic materials, the method of preforming the ribbon **10** consists of rolling the material to a desired thickness, forming it into a tube by drawing the ribbon through suitable dies or by passing it through suitable roll-forming trains and then heat treating until the material is at the correct temper. Surface conditioning such as anodizing or plating can also be applied to protect the structure from corrosion. Subsequently, the tube is elastically deformed again into a flat sheet or ribbon **10** and rolled into a suitable roll **14** for storage. If desired, the ribbon may be rolled onto a reel (not shown) for insertion into a dispensing or supporting structure.

In the case of a plastic such as high impact styrene or a polyamide the method of preforming comprises heating the plastic to a suitable working temperature and extruding it through an annular die into a thin cylindrical sheet having a desired width and thickness, in this manner preforming the tube of the required diameter.

In order to enable the tube to accommodate the slight plastic deformation which occurs in the rolling or reeling process, especially in tubes which are close to the critical ratio of width to wall thickness, it is advisable to form and temper a ribbon with the edges slightly overlapping rather than in an abutting relationship. This ensures, after the slight plastic deformation occurring during the rolling, that the ribbon will unroll with both longitudinal edges abutting. As shown in FIG. 1, since the ribbon **10** comprising the roll **14** has been preformed into a tubular shape and then rolled, as the ribbon is unrolled it will immediately return to its tubular shape **16**.

After the ribbon **10** has been unrolled and assumed its tubular shape **16**, the resulting structure is relatively rigid against deformation from compressive and tensile forces but is relatively free to twist and deform from torsional forces. Therefore, in FIG. 2 is shown a first method of providing rigidity against torsional forces by applying a strip of tape **20** having an adhesive or bonding agent on one side thereof such as plastic tape having a layer of contact adhesive to the outer surface of the tube to cover a seam **18** defined by the abutting longitudinal edges of the ribbon. For convenience, the tape **20** may be stored in a roll **22** and dispensed into contact with the tube **16** as it is unrolled. Once the tape is applied, it will not normally be subjected to peeling forces but rather it will be subjected to shear stresses of magnitudes well within the tensile and shear strength of conventional contact adhesive tapes.

By use of an adhesive tape as described above, after the tube has performed its desired function the tape may be removed and it and the ribbon rolled for storage. This